

REMARKS

This timely filed Reply is responsive to the Office Action mailed on January 24, 2006. Claims 1-12 were pending at the time of the Office Action. Claims 1-6 and 8-12 were rejected based on WO 03/048047 A1 (Inventor Park et al.; hereafter "Park"), while claim 7 was determined to be allowable if written in independent form. Park is also published as Published U.S. Application No. 2005095194.

In this Reply, claims 1, 3, 8 and 10 have been amended, claims 2, 7 and 9 cancelled, and new claim 13 added. Claim 13 is former allowable claim 7 rewritten in independent form. No new matter has been added. An amended abstract as well as Replacement drawings accompanies this Reply as requested by the Examiner.

According to the Examiner regarding Park:

The abstract of WO 03/048047 A1 discloses a method for making zinc oxide nanopowders by adding an organic substance containing an amine group or carboxyl group to an aqueous solution containing Zn^{2+} ions and nitrate ions, and heating the solution with agitation.

Please note that no distinction is seen or has been shown between the "organic substance containing a carboxyl group" set forth in WO 03/048047 A1 and the tartaric acid or citric acid of applicants' claim 5.

The difference between the applicants' claims and WO 03/048047 A1 is that the applicants call for solid state mixing of the organic acid and the metal nitrate salt, while WO 04/047048 calls for adding the organic compound to a solution containing metal ions and nitrate ions, however it is submitted that this difference would have been obvious to one of ordinary skill in the art at the time the invention was made because it is expected that the reaction would proceed between the organic compound and the metal nitrate salt would occur to produce the metal oxide, regardless of whether or not the reaction occurs in the solid phase (which appears to be the case for the applicants) or the liquid phase (which appears to be the case for WO 03/048047 A1). Please note that the courts have determined that the prior art can be modified to reject the claims as *prima facie* obvious as long as there is a reasonable expectation of success: please see the discussion of the *In re Merck & Co., Inc.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986) court decision set forth in section 2143.02 in the MPEP Rev. 3, Aug. 2005.

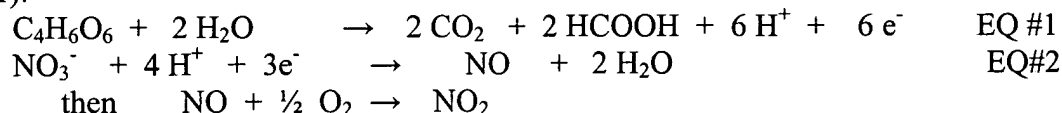
Applicants respectfully disagree with the Examiner's finding of obviousness based on Park. However, before reviewing Park, Applicant will review the claimed invention as recited in amended claim 1. Amended claim 1 recites:

1. A method of forming metal oxide powders, comprising the steps of:
solid state mixing of at least one metal nitrate salt and at least one reducing organic acid having a potential of > -0.957 volts at standard conditions for an electron generating reaction with water to reduce said nitrate and heating to a temperature in a first temperature range to form a metal oxide precursor complex comprising said metal, and
heating said metal oxide precursor complex to a temperature of at least 200°C but no more than 1200°C , wherein a metal oxide powder is formed.

Applicants' formation of the recited metal oxide precursor complex is via a redox reaction where the recited reducing organic acid has a potential of > -0.957

volts at standard conditions for an electron generating reaction with water which allows the reduction of the nitrate to proceed and form the metal oxide precursor complex comprising said metal. Support for the limitation "reducing organic acid having a potential of > -0.957 volts at standard conditions for an electron generating reaction with water" can be found in Applicants' paragraphs 22 and 23 copied below:

[0022] Tartaric acid is the organic acid used in the exemplary synthesis shown below. In this first step, nitrate anions NO_3^- from the metal salt are believed to be first reduced (EQ #2) by reaction products generated by the reaction tartaric acid ($\text{C}_4\text{H}_6\text{O}_6$) with water (EQ #1):



[0023] The reduction potential for EQ #2 is 0.957 volts at standard conditions (CRC Handbook of Chemistry and Physics- 78 th Ed. 1997-1998 page 8-23). Accordingly, for the reaction sequence of EQ #1 and EQ #2 to proceed spontaneously, the potential for EQ #1 must be > -0.957 volts. Therefore, as defined herein, the term "reducing acid" refers to an acid that provides a potential of > -0.957 volts at standard conditions for the electron generating reaction by the acid, such as EQ #1, thus providing the electrons for the spontaneous reduction of the nitrate anion and the resulting formation of the metal oxide powder.

Formation of the recited metal oxide precursor complex advantageously allows the claimed method to include processes performed on the metal oxide precursor complex, such as the step of grinding the precursor complex before the heating step recited in claim 12.

Support for the limitation "heating said metal oxide complex at a temperature of at least 200 °C but no more than 1200 °C" can be found in paragraph 18 (copied below):

[0018] The mixture is then heated to a temperature from about 200 °C to 1200 °C to form a metal oxide powder. The reducing acid provides electrons for the reduction of the nitrate ion NO_3^- , such as to NO_2 through a NO intermediate. The reducing organic acid is preferably a hydroxy acid, defined as any acid that has hydroxyl groups in addition to the hydroxyl group provided by the acid itself. Examples of hydroxy acids include 2-hydroxybenzoic acid, hydroxybenzoic acid, juniperic acid, salicylic acid, tartaric acid and citric acid. These acids are generally solids at room temperature. For example, tartaric acid is a white crystalline solid which has a melting point of about 172 to 174 °C.

The recited "heating said metal oxide complex at a temperature of at least 200 °C but no more than 1200 °C" has been added to amended claim 1 to emphasize that the reaction does not involve combustion which generates significantly higher temperatures, and only involves decomposition of the recited metal oxide complex.

Park discloses a method of preparing ZnO nanopowder according to a non-equilibrium synthetic process, comprising adding an organic substance containing an amine group or a carboxyl group as a fuel material to an aqueous solution having Zn^{2+} and (NO_3) ions to prepare a mixed solution, and heating the resulting solution with agitation. As clearly disclosed below, Park requires a fuel material to react with the nitrate groups in solution at some initial low temperature to "instantaneously generate" a very high temperature of "about 1500 to 1700 C" and high pressure to cause explosive combustion to prepare the metal oxide. According to Park (cites from corresponding published US application 2005095194)

[0025] An amount of each agent added to the solution is quantitatively calculated according to the chemical reaction equations below, and agents are added to the solution in the amount within a desirable range (in the non-equilibrium state) based on a calculated amount of the agent. Chemical reactions occurring in the present invention may be represented as follows:



[0026] The resulting solution is heated by a hot plate to a temperature capable of boiling water (for example about 80 to 200° C.), with agitation using a magnetic bar.

[0027] After distilled water is vaporized, the solution is converted into viscous liquid phase to form small bubbles and emit gas. The resulting liquid is then put in a collection device to react nitrate groups with the fuel to instantaneously generate very high heat (about 1500 to 1700° C.) and high pressure to cause explosive combustion, thereby preparing metal oxide, that is to say, zinc oxide (ZnO) powder.

The organic substance containing an amine group or a carboxyl group used as a fuel material by Park "is selected from the group consisting of carbohydrazide, oxalic dihydrazide, l-methyl-3-nitroguanidine, ammonium perchlorate, urea hydrogen peroxide, and guanidine nitrate in the above method". (last sentence paragraph 23 of the Published US application). Applicants have reviewed the comprehensive and frequently relied on Handbook of Chemistry and Physics--David R. Lide) in search for E° values for the fuels disclosed by Park. Of the fuels disclosed by Park listed above, E° values for only ammonium perchlorate and urea hydrogen peroxide were found. The E° values for ammonium perchlorate ($\text{ClO}_4^-/\text{Cl}_2$ is 1.39 V and $\text{ClO}_4^-/\text{ClO}_3^-$ is 1.189V and urea hydrogen peroxide (hydrogen peroxide E° is 1.776 V) are too high to reduce the nitrate group(since E° for the fuels are higher than that of NO_3^-/NO which as noted above is 0.957 V). Accordingly, Park teaches away from a process which reduces the nitrate group to form an intermediate complex.

Moreover, Park discloses a solution based method throughout, including each Example provided. Although the purpose of the water relating to the solution aspect of Park's invention is not disclosed by Park, it appears that the water is required to initiate the combustion of the fuel and the resulting attainment of a temperature of about 1500 to 1700 °C. Regardless of the purpose, since water is disclosed everywhere in Park, the addition of water is therefore taught as a requirement for practicing the Park invention.

In contrast to Park's solution-based method, Applicants' claimed method recites solid state mixing of the metal nitrate salt and reducing organic acid. Applicants respectfully disagree with the Examiner's assertion that based on Park:

Is expected that the reaction would proceed between the organic compound and the metal nitrate salt would occur to produce the metal oxide, regardless of whether or not the reaction occurs in the solid phase (which appears to be the case for the applicants) or the liquid phase (which appears to be the case for WO 03/048047 A1). Please note that the courts have determined that the prior art can be modified to reject the claims as *prima facie* obvious as long as there is a reasonable expectation of success: please see the discussion of the *In re Merck & Co., Inc.*, 800 F.2d 1091, 231 USPQ 375 (Fed. Cir. 1986) court decision set forth in section 2143.02 in the MPEP Rev. 3, Aug. 2005.

Since Park teaches the solution must contain a fuel for combustion, Applicants respectfully disagree with the Examiner's assertion that the claimed solid state mixture of the reactants would have been obvious to one skilled in the state of the art based on the asserted "reasonable expectation of success". First, combustion reactions almost always involve fluidic fuels (liquids and/or gases). Moreover, as noted above, one having ordinary skill in the art would be strongly motivated to follow Park's aqueous method because water clearly appears to be required to initiate Park's combustion reaction.

In contrast, Applicants' claimed solid state mixing recited in amended claim 1 avoids the step of preparing solutions required by Park resulting in a simpler procedure for production of the nanopowders. A simplified process sequence which eliminates a step to form a given product is regarded in the patent law as strong evidence of patentability over an earlier more complex process disclosed in a cited reference.

According to MPEP 2144.04 "Omission of an Element with Retention of the Element's Function Is an Indicia of Unobviousness" citing *In re Edge*, 359 F.2d 896, 149 USPQ 556 (CCPA 1966). In *Edge*, claims at issue were directed to a printed sheet having a thin layer of erasable metal bonded directly to the sheet wherein said thin layer obscured the original print until removal by erasure. The prior art disclosed a similar printed sheet which further comprised an intermediate transparent and erasure-proof protecting layer which prevented erasure of the printing when the top layer was erased. The claims were found unobvious over the prior art because although the transparent layer of the prior art was eliminated, the function of the transparent layer was retained since appellant's metal layer could be erased without erasing the printed indicia.

Based on Park's combustion-based solution method, Applicants submit that it a surprising result that metal oxide nanoparticles can be formed by solid state mixing (and without a fuel) . Solid state mixing a metal nitrate salt with any reducing organic acid would not produce the desired metal oxide product. As described above, the claimed solid state mixing process is made possible by the claimed reducing organic acid "having a potential of > -0.957 volts at standard conditions for an electron generating reaction with water". Accordingly, Applicants submit that Applicants' claimed process recited in amended claim 1 which includes the step of solid state mixing is a surprising result for which there is no reasonable expectation of success based on Park and is thus patentable over Park.

Moreover, amended claim 1 includes other limitations that are not disclosed or suggested by Park. Applicants' recited reducing organic acid having a potential of > -0.957 volts at standard conditions for an electron generating reaction with water is not

disclosed or suggested by Park as evidenced by the E° values for the fuels disclosed by Park which are provided in the Handbook of Chemistry and Physics as noted above. The claimed formation of the "metal oxide precursor complex comprising said metal" is not disclosed or suggested by Park. In addition, Applicants' claimed "heating said metal oxide precursor complex to a temperature of at least 200 °C but no more than 1200 °C, wherein a metal oxide powder is formed" is not disclosed or suggested by Park and is in fact taught away because Park's combustion process generates a temperature of about 1500 to 1700 C. Accordingly, amended claim 1 and its respective dependent claims evidence an inventive step and are thus patentable over the cited art.

Several dependent claims are believed to recited independently patentable limitations. For example, amended claim 8 amended recites "said first temperate range (used to form the claimed metal oxide precursor complex) is from 200 to 400 °C". Park uses a much higher temperature and does not form Applicants' claimed precursor complex. claim 10 recites the step of grinding said metal oxide precursor complex before said heating said metal oxide precursor complex . Since Park does not form a metal oxide precursor complex, Applicants recited grinding step is not possible based on Park's single step process.

Applicants have made every effort to present claims which distinguish over the cited art, and it is believed that all claims are clearly in condition for allowance.

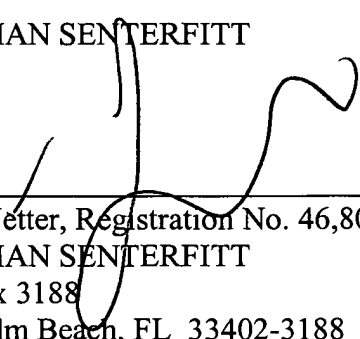
However, Applicants invite the Examiner to call the undersigned if it is believed that a telephonic interview (direct line (561) 671-3662) would expedite the prosecution of the application to an allowance. Although no fee is believed to be due, the Commissioner for Patents is hereby authorized to charge any deficiency in fees due or credit an excess in

fees with the filing of the papers submitted herein during prosecution of this application
to Deposit Account No. 50-0951.

Respectfully submitted,

AKERMAN SENTERFITT

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